Mark scheme

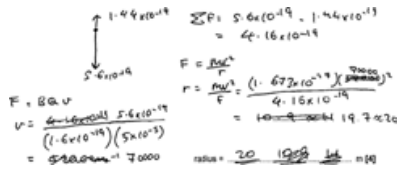
Question			Answer/Indicative content	Marks	Guidance
1	a	i	**Method 1** $d = 8.5 - 3.2$ (= 5.3(cm)) ($F = kd$ so) $F = 0.62 \times 5.30$ (= 3.3 (N)) $a = \frac{F}{m}$ so $a = \frac{3.3}{0.20}$ a = 17(m s^{-2}) **Method 2** ($F = kd$ so) $F = 0.62 \times 8.50$ (= 5.27(N)) $F_R = (0.62 \times 8.50) - (0.20 \times 9.81)$ (= 3.3 (N)) $a = \frac{F}{m}$ so $a = \frac{3.3}{0.20}$ **Method 3** ($F = kd$ so) $F = 0.62 \times 8.5$ (= 5.27(N)) $\left(a = \frac{F}{m} \text{ so}\right) a = \frac{5.27}{0.20}$ = 26 (m s^{-2}) $a_{initial}$ = 26.35 – 9.81 = 17 (m s^{-2})	C1 C1 A1 (C1) (C1) (A1) (C1) (C1) (A1)	**Mark whichever method leads to the most marks** d = 5.3cm does not need to be calculated explicitly but seeing 5.3 implies first C1 mark F = 3.3N does not need to be calculated explicitly but seeing 3.3 implies both C1 marks **Allow** k = 0.61 (N cm^{-1}) leading to F = 3.2 (N)... ... and a = 16 (m s^{-2}) F = 5.27(N) does not need to be calculated explicitly but seeing 5.27 or 5.3 implies first C1 mark **Allow** k = 0.61 (N cm^{-1}) leading to F = 5.19 (N) F = 3.3(N) does not need to be calculated explicitly but seeing 3.3 implies both C1 marks **Allow** k = 0.61 (N cm^{-1}) leading to F = 3.2 (N)... ... and a = 16 (m s^{-2}) F = 5.27(N) does not need to be calculated explicitly but seeing 5.27 or 5.3 implies first C1 mark **Allow** k = 0.61 (N cm^{-1}) leading to F = 5.19 (N) Note: a= 26 (ms^{-2}) is an intermediate calculation for $a_{initial}$ in this method only and is **not** the A1 mark **Allow** k = 0.61 leading to F = 5.19 and a = 16 **Examiner's Comments** There are two measurements for extension given here: an extension of 3.2cm under a load of (0.2 × 9.81) N and an extension of 8.5cm under a force of F + (0.2 × 9.81)

					The easiest way to approach the question is to recognise that the extension due to *F* alone must be (8.5 – 3.2) = 5.3cm. $F = kx$ then becomes $F = 0.62 \times 5.3$ (since *k* is given in N cm^{-1}) and so we can use $F = ma$ with $m = 0.2$kg to find the acceleration *a*. However, other valid methods were also given credit.
		ii	Use of $a = (-)\omega^2 x$ Use of $f = \frac{\omega}{2\pi}$ $f = 2.8$ (Hz) **Alternative method:** ($a = F / m = kx/m$ and $a = (-)(-)\omega^2 x$ gives) $\omega^2 = \frac{k}{m}$ $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ $= \frac{1}{2\pi}\sqrt{\frac{0.62 \times 100}{0.2}}$ $f = 2.8$ (Hz)	C1 C1 A1 (C1) (C1) (A1)	The two C1 marks are independent and XP in one does not imply XP in the other **Not** just formula alone Expect $a = 17$ but **allow** ECF of *a* from **(b)(i)** **Allow** any value for *x* **Not** just formula alone Use of $a = (-)(2\pi f)^2 x$ scores both C1 marks **Allow** $f = 2.9$ (Hz) **Allow** $T = 2\pi\sqrt{\frac{m}{k}}$ $f = \frac{1}{T}$ **Allow** $f = 2.9$ (Hz) **Examiner's Comments** The answer to this question is frequency = 2.8Hz, since ω depends only on *k* and *m* ($\omega^2 = k/m$). However, most candidates used the formula $a = (-)\omega^2 x$ together with appropriate values for *a* and *x*.
	b	i	(motion of magnet M causes) a change of flux (linkage) in coil Y (inducing an e.m.f.) there is an (induced) current in (or through) coil X alternating current / field / flux in coil X interacts with the field of magnet L (causing an alternating force)	B1 B1 B1	**Allow** field (lines of M) cuts (turns of) coil Y **Allow** the coil or Y or solenoid for coil Y **Allow** the coils or the wire(s) or X for coil X **Ignore** (induced) e.m.f. **Not** changing or varying or oscillating for alternating **Allow** current / field / flux in coil X

					interacts with field of magnet L **to** cause an alternating force **Allow** changing direction for alternating **Allow** combines for interacts **Allow** cuts across for interacts with **Examiner's Comments** Clarity in explanation was important here, as there are two magnets, M and L, plus two coils, X and Y. It is a change in flux linkage in coil *Y* which leads to an induced alternating current in coil *X*. This current creates an alternating magnetic field in coil *X* which interacts with the field of magnet *L* to create an alternating force on L. **Assessment for learning** Many explanations were too generalised: 'Faraday's Law states that there must be an induced emf which is proportional to the rate of change of flux linkage' or 'Fleming's left hand rule states there must be a force on the magnet' were often seen. Candidates should be encouraged to write in less general terms and to focus their answer on the specific question.
		ii	frequency of magnet L (always) equals (forcing/driving) frequency of vibration generator / magnet M resonance occurs at / close to 2.5 Hz amplitude is maximum at resonance	B1 B1 B1	**Allow** frequency of magnet increases with frequency of vibration generator May be seen from a **labelled** graph of amplitude against frequency **Allow** resonance occurs when forcing / driving frequency = natural frequency May be seen from a labelled graph of amplitude against frequency **Examiner's Comments** Many candidates did not realise that this was a question about resonance, presumably because of the unfamiliar context of the question.

					Common problems in 4(c)(ii) • not answering every part of the question: most candidates forgot to describe how the frequency varied as well as the amplitude • not realising that the vibration generator is driving the oscillation of L, and that this is a question about resonance • not labelling the scales on the graph of amplitude against frequency (or just using letters such as *A* and *f*) • failing to mark the resonance frequency as 2.5Hz (instead calling it f_o)
•			**Total**	**12**	
2	a		F (= EQ) = 0.90 × 1.60 × 10^{-19} = 1.4(4) × 10^{-19} (N)	B1	Working and answer must both be shown Answer must be given to 2sf or more Unit need not be given but, if given, must be correct **Examiner's Comments** This was an easy introduction to the question, which used the definition of electric field strength; $E = F_E / Q$. Being a 'show that' question, candidates needed to show their working in full, including writing the value for the electronic charge (rather than simply 'e') and giving the answer to at least 2 s.f.
	b	i	($F = BQv$ but B and Q are constant, so) (the magnitude of) the velocity is different /changes	B1	**Allow** speed **Ignore** the direction is different **Examiner's Comments** The force on a charged particle moving at right angles to a magnetic field is given by the formula $F_{mag} = BQv$. Since B and Q are constants in this case, the reason for the different magnitude of F must be that the proton has a different velocity, v.

					Common problems in 6(b)(i) • using the formula $F = BIl\sin\theta$ and suggesting that the proton might be travelling at a different angle to the field, not realising that the proton is always travelling at right angles to the magnetic field in this question • suggesting that the proton may be in a weaker (or stronger) field at X than at Y, not realising that the magnetic field is uniform and so its field strength is constant throughout
•		ii	$v = (\frac{F_{mag}}{BQ} =) \frac{5.6 \times 10^{-19}}{5.0 \times 10^{-5} \times 1.60 \times 10^{-19}}$ resultant force F_R= (5.6 − 1.4) × 10^{-19} $r = \left(\frac{mv^2}{F_R} =\right) \frac{1.673 \times 10^{-27} \times (7.0 \times 10^4)^2}{4.2 \times 10^{-19}}$ r = 20 (m) Alternative all-in-one method: $r = \frac{mF_{mag}{}^2}{F_R B^2 Q^2}$ resultant force F_R= (5.6 − 1.4) × 10^{-19} $r = \frac{1.673 \times 10^{-27} \times (5.6 \times 10^{-19})^2}{4.2 \times 10^{-19} \times (5.0 \times 10^{-5})^2 \times (1.60 \times 10^{-19})^2}$ r = 20 (m)	C1 C1 C1 A1 (C1) (C1) (C1) (A1)	v = 7.0 × 10^4 (m s^{-1}) implies first C1 **Allow** 10^{-19} for 1.4×10^{-19} (giving $\boldsymbol{F_R}$= 4.6 × 10^{-19}) F_R = 4.2 × 10^{-19} implies second C1 Do not credit if used as F_{mag} in F_{mag} in $F_{mag} = BQv$ Third C1 is for correct substitution into formula **Allow** m_p = 1.67 × 10^{-27} kg given to 3 s.f. **Not** m_p = 1.661 × 10^{-27} kg or m_p = 1.675 × 10^{-27} kg **Allow ECF** for incorrect v Use of $\boldsymbol{F_R}$ = 5.6 × 10^{-19} or = 1.4 × 10^{-19} is **XP** **Allow** r = 19 (m) $\boldsymbol{F_R}$ = **4.2 × 10^{-19}** (4.16 × 10^{-19} to 3sf) implies second C1 An incorrect value of F_R is **XP** from this point Third C1 is for correct substitution into formula **Allow** r = 19 (m) **<u>Examiner's Comments</u>** This question could not be done in one step, by equating the magnetic force to the centripetal force. This is

					because, at X, the centripetal force is being provided by a combination of forces from both the electric and the magnetic field. The easiest approach is to find the velocity of the proton using $F_{mag} = BQv$ (the value for F_{mag} is given in the diagram as 5.6×10^{19} N). This velocity v can then be used in the formula $F = mv^2/r$ in order to calculate the radius, r. F here is the *resultant* force towards the centre of the circle, which is found from magnetic force downwards - electric force upwards (the electric force having been calculated in part (a)). Exemplar 3 is an example of a correct answer, clearly written to show each stage in the calculation: Exemplar 3 
		iii	$\|\text{resultant force}\| = (\sqrt{3.9^2 + 1.4^2}) \times 10^{-19}$ $\|\text{resultant force}\| = 4.1 \times 10^{-19}$ (N)	C1 A1	**Ignore** attempt to calculate weight of proton **Allow** $F_E = 10^{-19}$ **Allow** $\|F\| = 4.0 \times 10^{-19}$ (N) using $F_E = 1.0 \times 10^{-19}$ **Allow** $\|F\| = 4.2 \times 10^{-19}$ (N) using $F_E = 1.44 \times 10^{-19}$ **Examiner's Comments** There are two forces acting on the proton at Y: an electric force upwards (given in (a)) and a magnetic force to the left (shown on the diagram). These two forces act at right angles to each other, and so the magnitude of their resultant can be found using Pythagoras's Theorem. Credit was given for using a value for the electric force to 1, 2 or more significant figures.

		iv	resultant / net force is not perpendicular to velocity work is done on proton (therefore kinetic energy changes so speed is not constant)	B1 B1	**Allow** direction of motion / path but **not** speed for velocity **Allow** acceleration / resultant force is not (always) towards centre (of circle) **Allow** electric force is not perpendicular to velocity / is in the same direction as velocity **Ignore** references to centripetal **Ignore** references to centripetal **Examiner's Comments** At Y, the proton is moving downwards, with a resultant force being the combination of an electric force upwards and a magnetic force to the left (calculated in part 1). The resultant force cannot be at right angles to the velocity, so we cannot have circular motion. The component of the resultant force acting in the direction of the proton's motion will do work on the proton and change its speed. So, the proton cannot be travelling at a constant speed.
			Total	**10**	
3	a		**Level 3 (5–6 marks)** Clear description **and** clear analysis *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Clear description or clear analysis or some description and some analysis *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Limited description or limited analysis *There is an attempt at a logical structure with a line of reasoning. The information is in the most part*	B1 × 6	Use level of response annotations in RM Assessor **Indicative scientific points may include:** Expect to see use of ac for clear description **Description** • labelled circuit diagram • smaller number of turns on primary • a.c. supply on primary • load resistor on output • a.c. ammeter to measure current • measurement of number of turns on secondary • keep number of turns on primary constant

			relevant. **0 mark** No response or no response worthy of credit.		• keep input ac voltage constant • increase number of turns on secondary each time **Analysis** • algebra to get to N_s α $1/I_s$ • graph drawn $1/ I_s$ against N_s / I_s against $1/N_s$ • expect straight line through origin or • lg Is against lg Ns • expect straight line to show gradient = −1 • therefore Ns α 1/Is or - **if load resistor in circuit only** • use of Ohm's law applied to load resistor to explain why presence of load resistor increases primary current • plotting graph drawn I_s against N_s • expect straight line through origin **<u>Examiner's Comments</u>** This Level of Response (LoR) question was designed to assess practical skills of planning, implementation, analysis and evaluation from Module 6 of the specification, specifically 6.3.3(f), along with HSW3 and HSW4. A holistic approach to marking is used, with marks given according to answers matching the descriptors for the various levels. No one answer is perfect for this question, and examiners were expecting a varied approach, with common themes, which would lead to a correct conclusion. The nature of the question is such that it can be conveniently separated into a description of the experiment and an analysis of it. The key points in the description that examiners were looking for were: - a

					suitable circuit diagram with a transformer and coils along with a supply and metres - use of an ac supply - a description of the method used, specifically controlling variables, and measuring an output - a statement or description of how the output current is to be determined - a statement of how the secondary turns is to be varied. The key points in the analysis that examiners were looking for were: - a statement of the transformer equation in terms of current and turns - a suitable arrangement of this formula to give either the dependent or independent variable as the subject - a suitable graph which would give a linear relation - an explanation of how this graph would appear. It was clear that many candidates had carried out this experiment by investigating voltage however the use of current here caused some difficulties to less successful candidates. The very best responses were detailed, with a clear diagram and well-structured making every attempt to fully answer each section. In many cases the diagram did little to add to the description, however the very best were suitable on their own. Many candidates had a single supply for both the primary and secondary turns and a significant number used a dc supply. Good responses often included the additional detail that the transformer was a step up so that there would be a larger number of turns on the secondary, often giving suitable numbers. Many candidates stated that they would plot secondary current against secondary turns and then stated that it would show inverse proportionality. It is to be explained that any relation should be shown through a straight line graph wherever possible. Exemplar 2

					 Exemplar 2 shows a response which does not necessarily have all the indicative points contained but would be given Level 3 and 6 marks. Firstly, the diagram doesn't have any method for measuring input current or have a load resistor, but it is clear what it represents and it also looks like it is a step-up transformer. The diagram has a dc cell symbol, but this is overridden by a statement that it is an ac supply in the text. This does not have to be treated as a contradiction, as the symbol for ac is not likely to be known. The method explains how this is to be carried out quite well and is structured in an ordered way. The analysis is brief but complete. It shows the equation that has been used, arranged in the form of y = mx + c and then stating what should be plotted and what it will show. This is an example of a perfectly good response that will achieve maximum marks without having to get every indicative point.
	b	i	The (magnitude of the induced) e.m.f. is (directly) proportional/equal to the rate of change of (magnetic) flux linkage	B1	**Allow** electromotive force for e.m.f **Do not allow** electromagnetic force for e.m.f. **Allow** change per unit time for rate of change **Allow** cutting flux for change of flux

					linkage **Do not allow** flux density for flux linkage **Examiner's Comments** It was encouraging to see that over half of the candidates were able to correctly recall Faraday's law, which is specifically stated in the specification. The vast majority of incorrect responses were a statement, generally in words, of the transformer equation presumably as it was used in the following question.
		ii	Use of $Ns / N_p = Vs / Vp$ N_s / 920 = 5.0 / 230 so N_s = 20	C1 A1	Expect to see attempt at substitution following the equation Correct substitution and correct algebra into any arrangement **Examiner's Comments** The vast majority of candidates were able to correctly show the number of turns on the secondary coil was 20. As always with a 'show that' question it is important that each step is clearly shown and that there is no doubt that the candidate has evaluated the answer. Candidates who did not score on this generally were not explicit enough in their working.
		iii	Use of $N = 20$ $3.4 = 20 \times \Delta\phi / 1.2 \times 10^{-3}$ $\Delta\phi = 2.0 \times 10^{-4}$ Unit: Wb / weber(s)	C1 C1 A1 B1	Expect to see factor of 20 correctly used Correctly calculated to 2sf (2.04) **Special cases:** for two marks from the calculation Use of $N = 1$ gives 4.08×10^{-3} correct to 2sf Use of $N = 920$ gives 4.43×10^{-6} correct to 2sf **Allow** T m^2 **Ignore** V s **Allow** correct base unit (kg m^2 s^{-2} A^{-1}) **Examiner's Comments**

					This question was generally well answered with over a third gaining all 4 marks. Most candidates chose the correct equation, although its rearrangement caused some problems, along with the number of turns to use. The correct numerical answer was 2.0×10^{-4} which several candidates incorrectly (in terms of significant figures) gave as 2×10^{-4} thus losing a mark. Candidates should be reminded that, in general, answers should be given to the lowest number of significant figures in the question, in this case 2sf. Many candidates who struggled with the calculation were able to get the standalone mark for the unit although there was a reasonable number of W rather than Wb. **Misconception** The formula stating $\Delta(N\Phi)$ seemed to cause some misunderstanding and a fair number of candidates seemed to calculate the difference in the number of turns (920 − 20) therefore using 900 as the number of turns.
			Total	**13**	
4			C	1	**Examiner's Comments** Most candidates were able to calculate the force, using F = BQv. The powers of ten in the various quantites appeared to have caused few problems. SThis was the multiple choice question that had the most 'no responses'.
			Total	**1**	
5			B	1	**Examiner's Comments** This question was correctly answered by a good proportion of the candidates, as it was a relatively simple two step calculation. The vast

					majority of incorrect responses showed little useful working, showing a lack of knowledge of transformers.
			Total	**1**	
6			C	1	**Examiner's Comments** The majority of candidates were correctly able to identify Faraday's law from a list of physical laws. Many candidates knew that it was related to electromagnetism and so the majority of incorrect responses were **A**.
			Total	**1**	
7			A	1	**Examiner's Comments** A majority of candidates were able to identify the correct response. The vast majority of incorrect responses were **A**, probably from the flux linkage at that point, rather than the rate of change of flux linkage.
			Total	**1**	
8			A	1	**Examiner's Comments** Just over half of the candidates correctly applied Fleming's Left Hand Rule to obtain the correct response. Candidates should be familiar with the terms 'into, down, out of, up' in relation to directions in this style of question.
			Total	**1**	
9			***Level 3 (5–6 marks)** Detailed method **and** analysis which clearly distinguishes between gamma, beta-plus and beta-minus *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.*	B1 × 6	Use level of response annotations in RM Assessor **Indicative scientific points may include:** **Method** • Measure background count and subtract from source count

			Level 2 (3–4 marks) Some method **and** analysis which clearly distinguishes between any two of the sources *There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Limited method **or** limited analysis *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*		• Clamp source pointing away from you • Safety precautions (handle source with tongs, limit time etc.) • Record count over fixed time period • Investigate variation of count rate with range • Place aluminium sheets between source and radiation counter • Set up magnetic field at right angles to emission direction in order to investigate deflection of charged particles • Move radiation counter to find direction of deflection **Analysis** • Gamma has longest range in air, beta minus and beta plus have similar range (or β^+ has shortest range due to annihilation in air) • Gamma penetrates aluminium which is (more than a few mm) thick whereas beta does not • Gamma is undeflected by magnet (because neutral) • Beta radiation is deflected by magnet (because charged particles) • Beta plus and beta minus are deflected in opposite directions • because they have opposite charges / beta plus particle is a positron and beta minus particle is an electron • Use Fleming's left-hand rule to determine charge on beta particle through the direction of its deflection • With beta-plus, current is in same direction as motion of particle (opposite for beta-minus) **Examiner's Comments** When marking a LoR question, the

					examiner first decides the level of response (1, 2 or 3) by considering the quality of the physics. The examiner then decides whether to award the top of the level (for a well-structured and relevant response) or the bottom of the level (for a poorly structured and mostly irrelevant response). In this LoR question, responses in Level 1 often contained insufficient key physics. The experiment described was extremely safe and painstaking but, at the end of the day, the three sources were not clearly distinguishable. Low level responses frequently included instructions on how to test for an alpha source. The magnet was often used either to pick up the sources or to attract/repel charged particles. In a typical top level response, the thickness of aluminium used to block beta (but not gamma) was specified. A perpendicular magnetic field was used to separate the charged particles and the direction of their travel was predicted using an accurate diagram and Fleming's left hand rule. There were three possible approaches: 1. Investigate the range in air. Gamma has the largest range and beta-plus the smallest (due to annihilation). (The answer 'both beta-plus and beta-minus have a similar range in air' was also accepted). 2. Investigate the path through a perpendicular magnetic field. Gamma is undeflected; beta-plus and beta-minus would deflect in opposite directions. 3. Investigate the penetrative power. Since the materials and thicknesses available were not specified, it was easiest to keep increasing the thickness and density of the materials until all but one of the sources was blocked, thus identifying the gamma

					source. Many candidates were unable to distinguish clearly between the two beta sources because they did not understand how beta-plus and beta-minus particles would travel in a magnetic field. Many candidates erroneously thought that a magnet had a positive pole (which would attract beta-minus) and a negative pole (which would attract beta-plus). **Misconceptions** • A bar magnet does not have positive and negative poles – it has north and south poles • A magnet does not attract or repel charges – it exerts a force on charged particles moving at right angles to its magnetic field
			Total	**6**	
10	a	i	Oscilloscope / CRO	B1	**Allow** a.c. voltmeter **Ignore** datalogger / multimeter **Examiner's Comments** Most candidates appreciated that a voltage was to be measured, however it was evident that only a small proportion realised that it would be alternating and so a simple "voltmeter" would not be sufficient. Candidates putting the correct response of "oscilloscope" may well be those who have carried out practical work using search coils.
		ii	**1** *f* **2** θ or sin θ	B1 B1	**Not** any other symbol. **Only** mark quantity letters – ignore any words, but allow frequency. **Allow** θ or sinθ with any or all of K, I_0, *A, N.* **Only** mark quantity letters – ignore any words.

					Examiner's Comments Part 1 was answered better than part 2 in general. For part 1, the majority of candidates appreciated that the "rate" will have included the frequency although many included other irrelevant (and therefore incorrect) terms too. In part 2, the concept of what causes the magnetic flux linkage to "change" did not appear to be well understood; *A* and/or *N* were often an incorrect response, presumably as the candidate was aware that these terms are included in a calculation for flux linkage.
		iii	$f = \frac{0.62}{5000 \times 4.0 \times 10^{-3} \times 8.0 \times 7.8 \times 10^{-5}}$ / f = 49.67…. (Hz) $\frac{0.2}{8.0}$ / $\frac{0.1}{7.8}$ / $\frac{0.03}{0.62}$ abs uncertainty = $(\frac{0.2}{8.0} + \frac{0.1}{7.8} + \frac{0.03}{0.62}) \times 49.67\ldots$ / 4.28… (Hz) f = 50 ± 4 (Hz)	C1 C1 C1 A1	Any individual raw uncertainty Max value = 54.11 (Hz) **and** min value = 45.54 (Hz) for *f* **Allow 8.6%** as evidence of this calculation For min / max method: difference / 2 = 4.29 (Hz) **Allow** ecf on abs uncertainty from incorrect *f* Any ecf on *f* must be given to 2sf and uncertainty sf consistent. **Not** the paper SF penalty **Examiner's Comments** A good fraction of candidates were able to score full marks on this question. It is clear that many had been well prepared in treatment of errors, and 8.6% was seen often in the working. A common mistake among more successful responses was giving the error as 4.3, rather than 4. Less successful often simply added the raw uncertainties, giving 0.33, which was often then placed on the answer line. Some candidates missed out the factor of 10^{-5} in their calculation of *f*. Other approaches to obtain errors, such as calculating maximum and minimum values for *f* were seen and these can also lead to full marks.

	b		When switch is opened, there is (rate of) change in (magnetic) flux (linkage) which induces an emf / current as the (magnetic) flux links to **B** which causes the lamp to light (Lamp off) at start / end there is constant flux / no change in (magnetic) flux (linkage for coil **B**)	B1 B1 B1	Not just a statement of Faraday's law **Allow** flux is cut by **B** **Examiner's Comments** Many candidates found difficulties in appreciating what was required. A major confusion arose from a misunderstanding of the actual process, in that it was the opening of the switch which caused the lamp to light. Many knew Faraday's law, and were able to quote it, but not able to put it correctly into the context of this question. A common error included a misunderstanding of the role of the rod. With a large number of less successful responses stating that it conducted current to the lamp. A large number of candidates did not discuss the process in the terms of magnetic flux (as was required in the question) but talked in vague terms about "magnetism". Despite this being a challenging question, many candidates were able to score marks, and those at the top end were able to give clear and well-structured responses.
			Total	**10**	
11			**A**	1	**Examiner's Comments** Most candidates who successfully answered this question showed working equating the magnetic force to the centripetal force to show that $mv = rBq$. Some had possibly learnt the formula $r = mv/Bq$ as this was also a common starting point.
			Total	**1**	
12			**C**	1	**Examiner's Comments** Most candidates appear to know that the force between the two wires would be attractive, and circled C or D as their options. A few used the diagram

					and the right hand rule to draw arrows to help with the direction. Both of these are good practice in this style of question. A little less than half of the candidates selected the correct response with the vast majority of incorrect responses being D.
			Total	**1**	